

CERTIFICATION REPORT

For

NJCAT VERIFICATION

Of

Brice Environmental Services Corporation
(Soil Washing Process)

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Introduction

New Jersey Corporation for Advanced Technology (NJCAT) submitted a verification report to New Jersey Department of Environmental Protection (NJDEP) describing the soil washing process of Brice Environmental Services Corporation. Through this verification report, in accordance with the New Jersey Environmental and Energy Technology Verification (EETV) Act at N.J.S.A. 13:1D-134, Brice Environmental Services Corporation seeks a certification, from NJDEP, which would establish its soil washing process as an Innovative Environmental Technology (IET). The EETV Act encourages the commercial development and use of new technology-based environmental and energy related products, services and systems, in the State, that abate and prevent environmental pollution, and promote energy conservation in the most cost-effective and environmentally efficient manner.

The water-based soil washing process of Brice Environmental Services Corporation is intended for use at Small Arms Firing Ranges (SAFRs) for removing lead from bullet fragments. To establish this soil washing process as an IET, the verification report from NJCAT includes data that was collected from four full-scale military SAFRs projects.

According to the verification report from NJCAT, the characteristics of the contaminants at the SAFRs are:

1. The contaminants exist as both discrete particles and sorbed compounds dispersed throughout the soil matrix.
2. Traditional bio-treatment methods of dealing with high explosives further complicate remediation process, since it increases the volume of material without addressing the toxicity/leachability associated with the particulate metals.

Also described in the verification report from NJCAT, the soil washing technique developed by Brice Environmental Services Corporation will be able to achieve the following:

1. Recover particulate metals from the soils as a refined product, and render soil non-toxic and suitable for reuse.
2. Provide a pretreatment step to reduce the volume of contaminants in the soil.
3. Use wet scrubbers/screens for dust-free deagglomeration and sizing.
4. Provide multi-stage coarse and fine gravity separations for particulate lead recovery and refinement for recycling.
5. Establish a closed-loop, water-based process with spill controls to eliminate airborne lead dust, while minimizing the required volume of process water.
6. Combat the high cost of remediating soils from SAFRs.

Technical Performance Claims of Soil Washing Process

As stated in the NJCAT verification report, the technical performance claims made for Brice Environmental Services Corporation (Brice Environmental) soil washing process are as follows:

Claim 1 – Brice Environmental’s water-based soil washing particulate recovery process is effective in removing particulate metal contaminants from Small Arms Firing Ranges, resulting in typical lead contaminant reductions of 90 percent in the treated soil, with the recovered metals suitable for commercial recycle.

Claim 2 – Brice Environmental’s water-based soil washing process effectively separates the soil fines and/or organic matter (humates) fractions containing sorbed contaminants from the coarse fractions, thereby reducing the volume of material requiring secondary treatment. The soil quantity meeting the clean up goal following soil washing alone is a function of the soil fines/humates fraction. Typically the soil available for reuse following the soil-washing process is in the 70 to 100 percent range.

Claim 3 – Brice Environmental’s soil washing process coupled with residual secondary treatment has been shown to be effective in rendering 100 percent of the treated soil suitable for reuse on site.

Summary of SAFRs Full-Scale Soil Washing Projects

To support the claims made for the soil washing process, the verification report from NJCAT describes four full-scale projects that were completed by Brice Environmental Services Corporation. A description of the projects, as outlined in the verification report, is as follows:

Project 1 – Small Arms Firing Range 24, Fort Dix, New Jersey.

- A minimum of 3,500 tons of lead contaminated soil was treated.
- The wash water was recycled within the plant in a closed system.
- Project time frame was September-October, 1999.

Project 2 – Massachusetts Military Reservation (MMR), Cape Cod, MA.

- Lead was identified as the primary contaminant in sandy soil, with lead sizes ranging from complete slugs to microscopic fines.
- The soil washing technique was able to separate the lead contaminants from the soil.
- Project time frame was October-December, 1999.

Project 3 – Marine Corps Air-Ground Combat Center (MCAGCC), 29 Palms, CA.

- At rifle range, impact berm and area behind impact berm identified with lead contamination of up to 35,000 mg/kg.
- The concentration of the lead-contaminated soil, at a depth of 2 feet below the ground surface, was 700 mg/kg.
- The sizes of the lead contaminant ranged from ¾ inch to 50-mesh particles.
- Project time frame was June-September, 1998.

Project 4 – Small Arms Firing Range 5, Ft. Polk, LA.

- Approximately 1,000 tons of shooting range soils to be treated using a continuous, closed-loop process.
- Project time frame was November-December, 1996.

NJCAT Verification of SAFRs Soil Washing Process

As indicated in NJCAT verification report, the resulting conditions from the SAFRs full-scale projects to satisfy the specific claims of Brice Environmental Corporation's soil washing process are as follows:

Claim 1

At Fort Dix, the amount of soil processed was 3,591 tons, and lead accounted for 84% (17.64 tons) of heavy metals recovered. The initial total lead concentration was determined to be 5,308 mg/kg. After the soil washing process, treated soil was determined to have a lead concentration of 396 mg/kg, which resulted in a particulate lead removal efficiency of 92.5%.

At MMR, the concentrations of the metal in the soil and fines were not measured, which could not produce an initial and final contaminant concentration. However, a total of 6,224 tons of soil was processed, which provided 50 tons of lead and other metals. An assay of the lead was calculated to be approximately 60%. Therefore, the lead content in the sample taken was assumed to be 30 tons (60% of 50 tons), which was used to deduce that the initial lead concentration was greater than 4820 mg/kg. In a treatability study, as described in the verification report, a removal rate of 98.4% for particulate metals in the plus-4-mesh ($\frac{1}{4}$ plus soil fraction) was attained. Therefore, it is assumed that the removal rate of the lead was in excess of 98%.

At MCAGCC, approximately 11,700 tons of soil was processed and 85% of the 207 tons of metals recovered was lead. The concentration of the residual lead content of 1,796 mg/kg in the treated soil when compared with the initial lead concentration (16,834 mg/kg) yielded a removal efficiency of 89.3%.

At Ft. Polk, the treated soil contaminant level was reported after secondary treatment, and the removal rate of the lead was calculated to 89.3%. An earlier analysis by another contractor assessed the removal of the course fraction of lead after the soil washing to be >90%.

Claim 2

For all test sites, the soil available for reuse following the soil washing process was between 70% and 100% of the processed amount.

Claim 3

At all test sites, the combination of the soil washing process and residual secondary treatment resulted in 100% of the soil suitable for reuse.

TABLE 1 – FULL-SCALE FIELD SOIL WASHING APPLICATIONS

<u>Site</u> (Year)	Range Use	Range Maintenance Practice	Soil Descriptio n	Soil Characterization %	Target Contaminant	Contaminant Concentration Average/Range ¹ (mg/kg)	Clean Up Goal (mg/kg)	Range Reuse Objective
Ft. Dix, NJ 1999	Small arms firing range	Refaced berm w/additional native soil	Sandy	Oversize – 0 Gravel/sand – 92.6 Fines – 7.4	Lead /Lead Particles	5,308 210-38,000	600 (400 ²)	Green Ammunition Firing Range
MMR, MA 1999	Small arms firing range	None	Sandy w/cobbles	Oversize – 69.7 Gravel/sand – 21.7 Fines – 8.6	Lead /Lead Particles	> 4820 ⁵	¹ / ₄ + (no visible) ¹ / ₄ - (TCLP <0.75 mg/l)	Green Ammunition Firing Range
MCAGCC CA 1998	Small arms firing range	None	Sandy/ Gravel	Oversize – 18.5 Gravel/sand – 72.9 Fines – 8.6	Lead /Lead Particles	16,834 27,000 – 233,000 ³	5,400	Bullet Trap/Small Arms Training
Ft. Polk, LA 1996	Small arms firing range	None	Silty sand/ clay	Oversize – 2.2 Gravel/sand – 64.9 Fines – 32.9	Lead /Lead Particles	4117 ⁴ 2743-5194 ⁴	500 TCLP < 5 mg/l	Small Arms Training

1 - Average is actual field average calculated from the total lead recovered and lead remaining in treated soil. Range is from treatability studies.

2 - Desired level

3 - Prior Battelle site characterization analysis

4 - Actual average field data from the 16 daily analyses

5 - See verification report

**TABLE 2 – PARTICULATE METAL REMOVAL EFFICIENCY
AND TOTAL METAL RECOVERED/RECYCLED (CLAIM 1)**

Site	Soil Processed (Tons)	Target Contaminant	Feed Soil Contaminant Level (mg/kg)	Treated Soil Contaminant Level (mg/kg)	Particulate Metal Removal Efficiency-%	Total Metal Recovered/Recycled (Tons)
Ft. Dix, NJ	3,591	Lead/Lead Particles	5,308	396	92.5	21
MMR, MA	6,224	Lead/Lead Particles	> 4820 ¹	$\frac{1}{4}$ + (zero visible) $\frac{1}{4}$ - (0.095 – 8.6 mg/l)	> 98 ¹	50
MCAGCC, CA	11,700	Lead/Lead Particles	16,834	1796	89.3	207 ²
Ft. Polk, LA	835	Lead/Lead Particles	4117	165 ³ 2.0 ± 0.29 mg/l ³	89.3	9

1 - See text for explanation

2 - Twenty-three (23) tons of non-metal residue was recovered along with 207 tons of metal in the “recovered metal concentrates”.

3 - Processed soil composite after secondary treatment

**TABLE 3 –PERCENTAGE OF PROCESSED SOIL MEETING CLEAN UP GOAL
FOLLOWING SOIL-WASHING (CLAIM 2)**

Site	Soil Processed (Tons)	Target Contaminant	Soil Meeting Clean Up Goal (Tons)	Soil Suitable for Reuse (%)	Soil Requiring Disposal/Secondary Treatment (Tons)
Ft. Dix, NJ	3,591	Lead/Lead Particles	3,570	100	0
MMR, MA	6,224	Lead/Lead Particles	4,974 (1/4 +) 599 (1/4 -)	90.3	601
MCAGCC, CA	11,700	Lead/Lead Particles	11,470	99.8	0
Ft. Polk, LA	835	Lead/Lead Particles	560 ¹	67.1	266

1 - Non-fines only. Fines were not analyzed prior to secondary treatment. It is assumed that all the fines would have failed the clean-up goals.

TABLE 4 – SECONDARY TREATMENT OF RESIDUAL CONTAMINATED SOIL (CLAIM 3)

Site	Soil Requiring Disposal/Secondary Treatment (Tons)	Soil Disposed (Tons)	Secondary Treatment Process	Soil Treated (Tons)	Treated Soil Available for Reuse (Tons)¹
Ft. Dix, NJ	0	NA	NA	NA	NA
MMR, MA	601	0	Stabilization	601	601 ²
MCAGCC, CA	0	NA	NA	NA	NA
Ft. Polk, LA	266	0	Acid Leaching	266	266 ³

NA- Not applicable

1 - The quantity of soil, following secondary treatment, that met the clean-up goals.

2 - This soil was reused on site with the restriction that it only be reused on an active berm.

3 - Since this treated soil exceeded the TCLP clean-up criteria, there were no restrictions on its reuse. However, it was reused on-site in an active berm, rather than bring in soil to rebuild the berm.

Net Environmental Benefit of Soil Washing Process

Based on NJCAT's verification report, NJDEP believes that the soil washing process of Brice Environmental Services Corporation will provide an overall net environmental benefit by protecting the land, waters, and air. The benefits to the respective media, which are summarized in table 5, are as follows:

Land

Treating the contaminated soils on site reduces the need for disposal to hazardous waste landfills. Similarly, if the treated contaminated soils are reused, the need for back-filling the excavated areas will be eliminated, thus eliminating any environmental impact to retrieve new soil. As indicated in NJCAT's verification report, 70% to 100% of the treated contaminated soils were reused at the facilities. Also, the soil washing process resulted in the reclamation of lead from the contaminated soils, which translates to a reduction of mining operations for lead ore.

Water

In lieu of leaving unattended, treatment of the contaminated soils reduces the risk of lead contaminating groundwater through leaching, and surface water via runoff. Even if the contaminated soils are diverted to hazardous waste landfills, then precautionary measures, such as capping, must be implemented to protect groundwater and surface water. In addition, the soil washing process, which is a closed system, produces no liquid effluent, thus reducing the volume of contaminated water to be treated.

Air

The soil washing process can also produce a profound benefit to the air quality. Hauling the contaminated soils to hazardous waste landfills and back filling the excavated areas require transportation vehicles, which are powered by diesel engines and are known to produce high SO₂, CO₂ and NO_x emission levels. Therefore, removing the transportation need reduces the levels of toxic emissions. In NJCAT's verification report, CO₂ emission output was assessed at 3.73 pounds for each mile traveled by diesel trucks to transport contaminated soils to hazardous waste landfills and backfill the excavated areas. This was compared with the emissions from the equipment used for the soil washing process, which was determined to be 2.80 pounds of CO₂ emission. Therefore, for each mile traveled, a reduction of 0.93 pounds of CO₂ is achieved. Although no analysis was done for SO₂ and NO_x emissions, it is assumed that any decrease of CO₂ emission will equate to a reduction in SO₂ and NO_x emissions.

Energy

The soil washing process and mining operations for lead ore require the consumption of energy. However, according to the analysis by NJCAT, the energy required for mining of lead is considerable greater than that required for retrieving lead through the soil washing

process. According to NJCAT's analysis, the energy required to retrieve one ton of lead from the soil washing process is 8.3 kWh, whereas mining for one ton of lead requires 435 kWh of energy.

Table 5 - Net Environmental Benefit

Media	Benefits of Using Soil Washing Process
Land	<ul style="list-style-type: none"> ▪ Immediate reusable soil range from 70% - 100%. ▪ Reduction of lead-mining operation. ▪ Reduction of materials destined for hazardous waste landfills. ▪ Reduced environmental impact due to back filling operations.
Water	<ul style="list-style-type: none"> ▪ Prevent groundwater and surface water contamination. ▪ Closed-loop system results in less volume of recycled wash water for treatment.
Air	<ul style="list-style-type: none"> ▪ Reduces need of transportation and related equipment thus reducing emission of CO₂ by approximately 25%.
Energy	<ul style="list-style-type: none"> ▪ Energy required for retrieving one ton of lead from contaminated soils is approximately 98% less than that needed for mining operations.

NJDEP Certification of NJCAT's Verification of Soil Washing Process

As required by the EETV Act, before receiving a certification from NJDEP, New Jersey Corporation for Advanced Technology (NJCAT) must complete a verification of the technology or process in accordance with its "Technology Verification Program General Verification Protocol". The EETV Act encourages the commercial development and use of new technology-based environmental and energy related products, services and systems, in the State, that abate and prevent environmental pollution, and promote energy conservation in the most cost-effective and environmentally efficient manner. NJCAT submitted a verification report, which documents that the performance claims were satisfied and the soil washing process of Brice Environmental Services Corporation will result in an overall net environmental benefit.

After reviewing verification of the performance claims and potential overall net environmental benefit, NJDEP hereby **certifies** NJCAT's verification report of Brice Environmental Services Corporation soil washing process. This certification of NJCAT's verification of the soil washing process as an innovative environmental technology allows its use in the State of New Jersey to

remove lead from contaminated soils at SAFRs. Based on NJCAT's verification report, the soil washing process can benefit all media of the environment and provide financial benefits.

NJDEP Commitment to Reciprocity Acceptance

After a NJCAT's verification report receives a certification from NJDEP, a technology or process that provides a net environmental benefit qualifies for acceptance through a reciprocity agreement by other Technology Acceptance Reciprocity Partnership (TARP) States. This reciprocity agreement defines a process whereby California (CA), Illinois (IL), Massachusetts (MA), New Jersey (NJ), New York (NY), Pennsylvania (PA), and Virginia (VA) adopted a common pathway for the reciprocal evaluation, acceptance and approval of environmental technologies. The TARP States have developed Tier II protocols to provide the necessary guidelines for developing technologies or processes that will be beneficial to the environment.

Presently, there is no TARP Tier II protocol that would provide guidelines to qualify the soil washing process of Brice Environmental Services Corporation for reciprocity acceptance. However, NJDEP has determined that the demonstration of the soil washing process satisfies the guidelines as set forth in the Interstate Technology and Regulatory Corporation (ITRC) document titled "Technical and Regulatory Guidelines for Soil Washing", dated December 1997. Therefore, NJDEP will offer any assistance necessary to promote the use of Brice Environmental Services Corporation soil washing process within any interested ITRC States. Please note that there may be limitations associated with the acceptance of this soil washing process, such as site location, lead contamination levels, climatic conditions, and volume of contaminated soil to be treated.